

REMARKS

Claims 19-24 stand rejected under 35 U.S.C. § 103 as being unpatentable over Cabral, Jr. et al. '440 ("Cabral") in view of Kwon et al. ("Kwon"), and claims 25-30 stand rejected under 35 U.S.C. § 103 as being unpatentable over Cabral in view of Kwon and Grill et al. '747 (Grill et al. relied on only for dividing the interlayer insulating film). Claims 19 and 25 are independent. These rejections are respectfully traversed for the following reasons.

Claims 19 and 25 each embody a first barrier layer that is made from a tantalum nitride film and a second barrier layer that is made from a tantalum film having a β -crystal structure. It is respectfully submitted that neither Cabral nor Kwon, alone or in combination, disclose or suggest the *combination* of a TaN/Ta(β -crystal) laminated layer. The Examiner relies on Cabral for disclosing a laminated TaN/Ta(α -crystal) layer and relies on the single Ta(β -crystal) layer taught by Kwon to modify Cabral in an attempt to reach the claimed invention.

However, Kwon discloses only a Ta(β -crystal) formed on a silicon oxide insulating layer under conditions whereby the β -crystal structure can be formed. Indeed, this is merely cumulative to the prior art described at col. 1, lines 49-52 of Cabral regarding a single beta Ta layer formed on an insulator such as silicon oxide, whereas Cabral is specifically directed to forming an α -crystal Ta layer *so as to avoid* the high-resistivity β -crystal Ta layer. To accomplish this, Cabral expressly discloses a *hexagonal* phase TaN as the underlayer so that a Ta layer formed thereon can *only* have an α -crystal structure (see col. 6, lines 14-22 of Cabral). Neither Cabral nor Kwon disclose or suggest the combination of a Ta film having a β -crystal structure on a TaN film, let alone

enable such an arrangement. As mentioned above, Cabral's underlayer is specifically configured to allow only an α -crystal to be formed thereon and to prevent formation of a β -crystal structure.

The Examiner is directed to MPEP § 2143.03 under the section entitled "All Claim Limitations Must Be Taught or Suggested", which sets forth the applicable standard:

To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. (citing *In re Royka*, 180 USPQ 580 (CCPA 1974)).

In the instant case, the pending rejection does not "establish *prima facie* obviousness of [the] claimed invention" as recited in claims 19 and 25 because the proposed combination fails the "all the claim limitations" standard required under § 103.

Moreover, any attempt to modify Cabral to utilized a laminate including Ta(β -crystal) would render Cabral unsatisfactory for its expressly stated purpose of a reduced resistivity by NOT using a β -crystal structure. The Examiner is directed to MPEP § 2143.01 under the sub-title "The Proposed Modification Cannot Render the Prior Art Unsatisfactory for its Intended Purpose", which sets forth:

If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. (citing *In re Gordon*, 221 USPQ 1125 (Fed. Cir. 1984)).

Furthermore, the asserted motivation of improving adhesion is based on the assumption that a Ta(β -crystal) is being used in the first place. That is, Kwon does not suggest using Ta(β -crystal) to improve adhesion. Rather, Kwon suggests forming an interfacial layer to improve the adhesion *specifically of a Ta(β -crystal)*. In other words, the improved adhesion of Kwon is NOT derived from using a Ta(β -crystal) layer rather

than a Ta (α -crystal) layer, but instead, the improved adhesion is derived from forming an interfacial layer when already using a poorly adhered Ta(β -crystal) layer. Indeed, Cabral appears to suggest at col. 1, lines 49-50 that Ta(β -crystal) adheres poorly and Kwon merely discloses how to improve adhesion specifically in a Ta(β -crystal) layer by forming an interfacial layer. Whereas, Cabral uses a α -crystal Ta layer and teaches away from a Ta(β -crystal) layer so as to have no need for a Ta(β -crystal) layer, let alone improved adhesion. In this regard, Cabral teaches away from the claimed invention. The Examiner is directed to MPEP § 2141.02 under the section entitled "Prior Art Must Be Considered in its Entirety, Including Disclosures that Teach Away from the Claims", which sets forth the applicable standard:

A prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention. (citing *Gore v. Garlock*, 220 USPQ 303 (Fed. Cir. 1983)).

Accordingly, the teachings of Kwon are not applicable to Cabral because to begin with, Cabral does not use a β -crystal Ta layer whose adhesive property needs to be improved by forming an interfacial layer. It is therefore respectfully submitted that there is no motivation to replace the Ta(α -crystal) layer of Cabral with the Ta(β -crystal) of Kwon for the asserted motivation of improving adhesion because Cabral already has a better adhesive property using the Ta(α -crystal) layer.

Under Federal Circuit guidelines, a dependent claim is nonobvious if the independent claim upon which it depends is allowable because all the limitations of the independent claim are contained in the dependent claims, *Hartness International Inc. v. Simplimatic Engineering Co.*, 819F.2d at 1100, 1108 (Fed. Cir. 1987). Accordingly, as claims 19 and 25 are patentable for the reasons set forth above, it is respectfully

submitted that all claims dependent thereon are also patentable. In addition, it is respectfully submitted that the dependent claims are patentable based on their own merits by adding novel and non-obvious features to the combination.

For example, with respect to claims 22 and 28, the Examiner apparently relies on col. 2, lines 49-54 of Cabral as allegedly disclosing “wherein a value of (a number of nitrogen atoms)/(a number of tantalum atoms) of the tantalum nitride film is 0.4 or less.” However, Cabral discloses only that the N/TaN ratio ranges from 30-60%. That is, the nitrogen content relative to TaN ranges from 0.3-0.6, whereby the corresponding Ta content relative to TaN is 0.7-0.4, respectively. Accordingly, the N/Ta ratio ranges from 0.3/0.7 to 0.6/0.4, that is, 0.43-1.5. In contrast, claims 22 and 28 embody a N/Ta ratio of 0.4 or less, which ratio can help enable forming the Ta(β -crystal) on the TaN film. As mentioned above, Cabral does not desire a β -crystal structure and therefore expressly teaches away from a N/Ta ratio that can enable formation of a β -crystal structure.

Based on all the foregoing, it is submitted that claims 19-30 are patentable over the cited prior art. Accordingly, it is respectfully requested that the rejection of claims 19-30 under 35 U.S.C. § 103 be withdrawn.

New claims 37-43 are submitted to be patentable for reasons similar to those discussed above.

New claims 44-51 are submitted to be patentable over the cited prior art. In order to clarify the distinction between claim 44 and the cited prior art, a personal interview was conducted with Examiner Cao. Applicants and Applicants’ representative would like to thank Examiner Cao for his courtesy in conducting the interview and for his assistance in resolving issues.

As a preliminary matter, it is respectfully submitted that the product-by-process limitation recited in claim 44 must be given patentable weight because it implies the structure of the invention by imparting distinctive structural characteristics to the final product. The Examiner is directed to MPEP § 2113, which sets forth the applicable standard:

The structure implied by the process steps should be considered when assessing the patentability of product-by-process claims over the prior art, especially ... where the manufacturing process steps would be expected to impart distinctive structural characteristics to the final product. (citing *In re Garnero*, 162 USPQ 221 (CCPA 1979)).

In the instant case, the claimed depositing and annealing process impart a distinctive structural characteristic in that an interfacial layer between the barrier layer and conducting film is not formed so that the *final* product, to be used in actual devices, has at least a portion of the barrier layer which directly contacts the conducting film. In contrast, Kwon expressly discloses annealing at a sufficient temperature to form the interfacial layer as part of the final product which prevents the copper and Ta films to directly contact each other. Indeed, as set forth on lines 4-5 of the Abstract, Kwon states that “Cu reacts readily at 400°C with Ta to form a thin interfacial amorphous interfacial layer that promotes the adhesion of Cu to Ta.” That is, Kwon expressly controls the parameters of the annealing process to ensure formation of the interfacial layer for the final product as a means to improve the adhesion between the Cu/Ta layer, so as to prevent contact between the Cu and Ta layers in the final product.

In contrast, claim 44 embodies a process by which an annealing step is conducted which does not form an interfacial layer that prevents the barrier layer and conducting film from directly contacting each other after the anneal (e.g., 150°C; *see, e.g.*, page 13,

line 21 of Applicants' specification). Accordingly, the present invention can provide a semiconductor device without Kwon's high-resistivity *amorphous* interfacial layer, for use as a final product.

During the interview, the Examiner alleged that the "interfacial layer" formed in Kwon could be interpreted as the conducting film so that after annealing the conducting film and barrier layer are directly contacting. However, claim 44 recites in pertinent part, "wherein said barrier layer and conducting film are sequentially deposited so that at least a portion of the barrier layer directly contacts the conducting film *after which* an annealing step is conducted, and wherein *after* the annealing step, *said* at least a portion of the barrier layer directly contacts the conducting film" (emphasis added). In contrast, the alleged "conducting film" in Kwon (i.e., interfacial layer) does not exist before annealing so that Kwon is limited to using the aforementioned high-resistivity amorphous interfacial layer in the final product. Indeed, as discussed above, Kwon expressly desires the interfacial layer as a means to promote adhesion.

CONCLUSION

Having fully and completely responded to the Office Action, Applicants submit that all of the claims are now in condition for allowance, an indication of which is respectfully solicited. If there are any outstanding issues that might be resolved by an interview or an Examiner's amendment, the Examiner is requested to call Applicants' attorney at the telephone number shown below.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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